NOTES ON THE TAXONOMY AND DISTRIBUTION OF CALIFORNIA *SALIX*

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ABSTRACT

There are 29 taxa of native *Salix* and two species of naturalized tree willows in California. Notes on the taxonomy and distribution of these willows, made during the study of *Salix* for *The Jepson Manual*, are presented. The data included are synonymy, a statement of geographical distribution, comments on taxonomic problems and hybridization, and dot distribution maps. A key is presented to the naturalized species, hybrids, and cultivars. The greatest biodiversity of *Salix* is in the Sierra Nevada Region and the lowest in the Desert Region.

During the preparation of a treatment of *Salix* for *The Jepson Manual* (Hickman 1993) notes were made on taxonomic problems, synonymy, and distribution that could not be included in the flora. The purpose of publishing this information is to bring attention to taxonomic problems and encourage their investigation. It is also an opportunity to present current thinking on the taxonomy of some taxa and to make distribution maps available. This is the first time that California *Salix* have been mapped, other than the tree willows (Little 1971, 1976).

MATERIALS AND METHODS

Taxonomic and distributional data were obtained from the study of herbarium specimens in CAN, CAS, DS, F, JEPS, MO, NA, NY, POM, RSA, SFV, UC, US, and WTU (abbreviations after Holmgren et al. 1990). Locality data for many specimens were recorded. Latitude and longitude, when not given on the labels, were determined using the *Geographical Names Information System California*, 1991. U. S. Geological Survey, Reston, VA. Mapping coordinates were entered into a dBASE file. Distribution maps were plotted using the database manager inFOcus (Earth and Ocean Research Ltd., Dartmouth, Nova Scotia) and QUIKMap (AXYS Software Ltd., Sidney, British Columbia) as described by Haber (1993). Some range details may be lacking because mapping coordinates could not be found for all specimens; additions and corrections would be welcome.

The geographical occurrence of taxa in California was determined using an overlay of the geographic subdivisions of California (Hickman 1993). For most species there are minor differences in geo-

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graphical occurrence as given in *The Jepson Manual* (Hickman 1993). This was because the original ranges were based on lists of localities and not on actual maps.

The synonymy accounts for names used in California floras (Bebb 1880; Hickman 1993; Jepson 1923; Mason 1957; Munz 1959, 1968, 1974), the flora of the Pacific Northwest (Hitchcock et al. 1964), and recent taxonomic literature. Full citations are given only for accepted names and their basionyms. Nomenclatural changes from *The Jepson Manual* treatment are indicated by cross-references in the taxonomic section.

Taxonomy and Distribution of Native Willows

Salix arctica sensu *The Jepson Manual* = *S. petrophila.*

1. *Salix bebbiana* Sarg. Gard. & For. 8:463. 1895

Modoc Plateau. Known only from south of Lower Klamath Lake, Siskiyou Co., and the southeast shore of Modoc Lake, Modoc Co. Map 1. Newfoundland to Alaska southward to Maryland and South Dakota, and, in the Cordillera, to Arizona and New Mexico; Eurasian.

2. *Salix boothii* Dorn, Canad. J. Bot. 53:1505. 1975

S. pseudocordata auctt. misapplied not (Andersson) Rydb.

Klamath Ranges, High Cascade Ranges, North and Central High Sierra Nevada, Modoc Plateau (Warner Mts.), East of Sierra Nevada (White Mts., Fishlake Valley drainage). Map 2. British Columbia and Alberta southward to Arizona and New Mexico.

3. *Salix brachycarpa* Nutt. N. Am. Sylva 1:69. 1842. var. *brachycarpa*

Central High Sierra Nevada. Known only as a disjunct population in Convict Creek Basin, Mono Co. Map 1. Alaska to Quebec southward in the Cordillera to California and New Mexico.

4. *Salix breweri* Bebb in S. Watson, Bot. Calif. 2:88. 1879

Outer and Inner North Coast Ranges, San Francisco Bay Area, Outer and Inner South Coast Ranges. Map 3. Endemic to California. See *S. delnortensis.*

5. *Salix delnortensis* C. K. Schneider, J. Arnold. Arbor. 1:96. 1919

S. breweri Bebb var. *delnortensis* (C. K. Schneider) Jeps.

Klamath Ranges. Known only from Del Norte Co, CA, and Josephine Co., OR. The California population is restricted to the banks of the Smith River. Map 4. Endemic to California and Oregon.

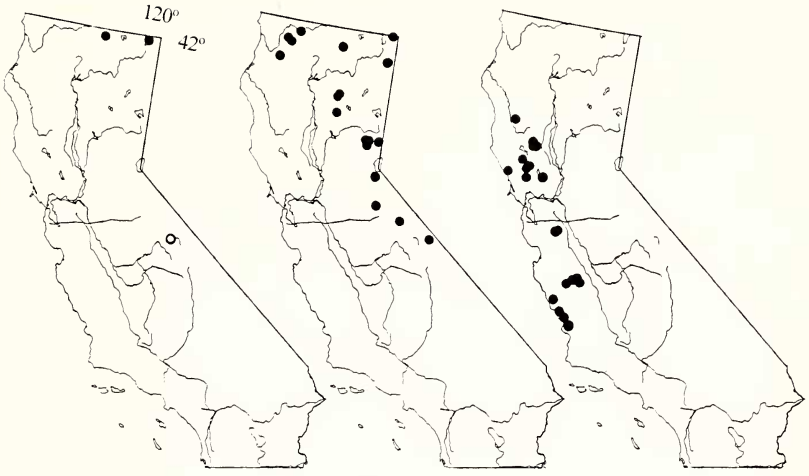

Fig. 1.
• *Salix bebbiana*
○ *Salix brachycarpa*

Fig. 2.
• *Salix boothii*

Fig. 3.
• *Salix breweri*

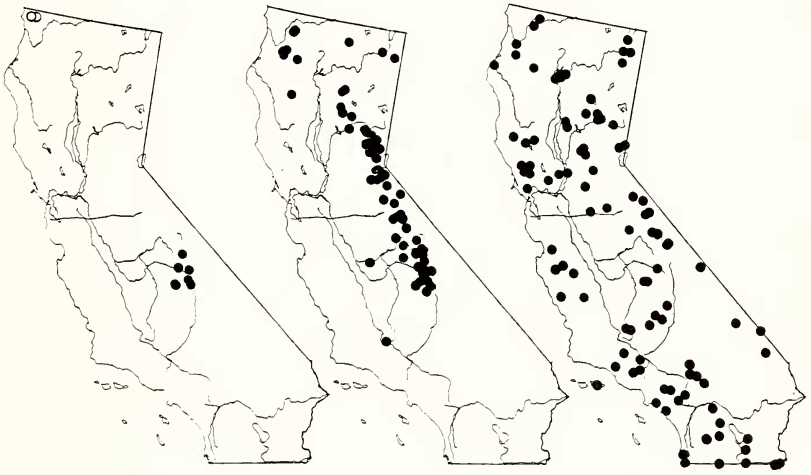

Fig. 4.
○ *Salix delnortensis*
• *Salix drummondiana*

Fig. 5.
• *Salix eastwoodiae*

Fig. 6.
• *Salix exigua*

Maps 1–6.

The lack of variation in herbarium specimens of *S. delnortensis* suggests that it is a single, interbreeding population. This species has usually been compared with *S. breweri* (Schneider 1919:97) and is sometimes treated as a variety of that species (Jepson 1923). In a phenetic study (Argus 1997), the overall morphology of *S. delnortensis* placed it nearest to *S. jepsonii* and *S. sitchensis*, followed by *S. drummondiana, S. riskindii* M. C. Johnston, and *S. breweri*. Based on these data, it was included in *S.* sect. *Sitchenses* (Bebb) C. K. Schneider, along with *S. sitchensis* and *S. jepsonii*. *Salix breweri* was placed in the closely related, monotypic section, *S.* sect. *Breweri* C. K. Schneider. A case could be made, however, for placing them all in the same section. The question of the relationship of these species could well be studied using molecular techniques.

Dorn's (1976) hypothesis that *S. delnortensis* is a hybrid between *S. lasiolepis* and *S. sitchensis* is not supported by my studies but it should be tested further.

6. *Salix drummondiana* J. Barratt ex Hook. Fl. bor.-am. 2:144. 1838

S. drummondiana var. *subcoerulea* (Piper) C. R. Ball; *S. subcoerulea* Piper

Southern High Sierra Nevada (Kings Canyon and Sequoia National Parks and Inyo National Forest). Map 4. Western North America from the Yukon and Northwest territories southward in the Cordillera to California and New Mexico.

A putative hybrid, *S. drummondiana* × *S. jepsonii*, with long stigmas, dark brown floral bracts, and no seed development, was collected at Alta Meadows, Sequoia National Park, Tulare Co. (*Parks 1042* NA)

7. *Salix eastwoodiae* Cockerell ex A.A. Heller, Cat. N. Am. Pl. ed. 3 89. 1910

S. californica Bebb; *S. commutata* auctt. not Bebb; *S. commutata* var. *denudata* auctt. not Bebb

Klamath Ranges, High North Coast Ranges, High Cascade Range, San Joaquin Valley (high elevations in Fresno and Kern cos.), Modoc Plateau (Warner Mts.), East of Sierra Nevada. Map 5. Washington and Montana southward to California and Colorado.

Authors have reported *S. commutata* from Trinity, Siskiyou, and Modoc cos. (Jepson 1923, Mason 1957, Munz 1959), but it was not included in *The Jepson Manual* (Argus 1993). Specimens from Modoc Co. were reidentified as *S. boothii*, and specimens from Trinity and Siskiyou cos. were reidentified as *S. eastwoodiae*. Dorn (1975) also recognized only *S. eastwoodiae* in California. He separated *S. eastwoodiae* and *S. commutata* by ovary indumentum (sericeous vs. glabrous, respectively) and chromosome number (tetraploid vs. dip-

loid, respectively). He further noted that *S. eastwoodiae* had proximal leaves (and leaves on flowering branchlets) mostly narrower and prominently glandular-margined. My observations show that these species are often the same in these characters and are, in reality, very difficult to separate. Furthermore, the single specimen of *S. eastwoodiae*, on which the chromosome number difference is based (*Dorn 1866*, RM, CAN), is an unusual specimen in which the proximal leaves, and leaves of the flowering branchlets, lack glandular margins. The reported difference in capsule indumentum (Dorn 1975) also is variable. Collections of *S. eastwoodiae* from Green Lake, Bishop Creek Region, Inyo Co. (*Leschke 6* Aug 1944, and *Raven & Stebbins 248* CU) include plants with both sericeous and glabrous ovaries. Further study is needed to determine if *S. commutata* is separable from *S. eastwoodiae* and if it occurs in northern California.

Putative hybrids *S. eastwoodiae* × *S. lemmonii* have been seen from Minear, Tehama Co., and Sulphur Works, Lassen Co.

8. *Salix exigua* Nutt. N. Amer. Sylv. 1:75. 1842

S. argophylla Nutt.; *S. exigua* var. *parishiana* (Rowlee) Jeps.; *S. hindsiana* Benth.; *S. hindsiana* var. *leucodendroides* (Rowlee) C. R. Ball; *S. hindsiana* var. *parishiana* (Rowlee) C. R. Ball; *S. longifolia* var. *argophylla* Andersson, *S. longifolia* var. *exigua* (Nutt.) Bebb; *S. sessilifolia* var. *hindsiana* (Benth.) Andersson; *S. sessilifolia* var. *leucodendroides* (Rowlee) C. K. Schneider

Throughout California but absent from the Tehachapi Mts., the Central Coast, and the White and Inyo Mts. Gaps occur in the Outer North Coast Ranges, High Sierra Nevada, San Joaquin Valley, South Coast Ranges, central Mojave Desert, and northeastern Sonoran Desert. Map 6. British Columbia to Saskatchewan southward to northern Mexico.

Plants of *S. exigua* with spreading hairs on leaves and branchlets; long (0.6–1 mm) slender stigmas; and more or less entire leaves are often referred to *S. hindsiana* (Brunsfeld et al. 1992; Munz 1959, 1974). Plants exhibiting these characters occur throughout California. This taxon has not been recognized (Argus 1993) because its characters are so variable that many specimens could not be named with confidence. The problem is compounded, nomenclaturally, because the type of *S. hindsiana* does not have long stigmas, they are only 0.25–0.4 mm long, or leaves with distinctly spreading hairs. The variant named *S. hindsiana* may reflect ancient hybridization and introgression between *S. exigua* and *S. sessilifolia* as asserted by Brunsfeld et al. (1992) but I have not been able, based on morphology or geography, to separate these plants from *S. exigua*. Further study is needed.

9. *Salix geyeriana* Andersson, Sv. Vet.-akad. Öfvers. 15:122. 1858

S. geyeriana var. *argentea* (Bebb) C. K. Schneider; *S. geyeriana* var. *meleina* J. K. Henry

High Cascade Ranges, Southern Sierra Nevada Foothills, High Sierra Nevada, San Bernardino Mts. (disjunct at Big Bear Lake), Modoc Plateau (Dorris, Siskyou Co., Fletcher Cr., Modoc Co., and Warner Mts.), and East of Sierra Nevada (White Mts.). Map 7. British Columbia and Montana southward to California and New Mexico.

Salix geyeriana is similar to, but distinct from, *S. lemmonii*. The two are often difficult to distinguish except on the basis of several variable characters including branch glaucousness, leaf size, leaf blade hair density and color, size and shape of catkins, anther length, petiole length, and chromosome number (Argus 1993). Important differences are chromosome numbers: *S. geyeriana* $2n = 38$, *S. lemmonii* $2n = 76$ (Dorn 1975); and catkin size and shape: *S. geyeriana* catkins are short and subspheric and those of *S. lemmonii* are longer and cylindrical. Hybridization between *S. geyeriana* and *S. lemmonii* is rare but seems to occur in Sierra and Lassen cos. Sympatric populations of these species occur in Modoc Co., Fletcher Cr., Devil's Garden; Mono Co., 23 mi. west of Bridgeport; Plumas Co., Portola and Sierra Valley; Tulare Co., Taylor Meadows, Pine Flat, and Left Stringer; and Nevada Co., Hirshdale, Boca Dam, and Sagehen Creek Field Station. Field studies of these populations may indicate the extent to which the two hybridize and how they can best be separated. See *S. lemmonii*.

Salix geyeriana can be distinguished from *S. drummondiana* by having the abaxial surface of leaf blade moderately silky vs. densely silky, midrib silky vs. midrib glabrous, and margins flat vs. revolute.

10. *Salix gooddingii* C. R. Ball, Bot. Gaz. 11:376. 1905

S. gooddingii var. *variabilis* C. R. Ball; *S. nigra* auct. non Marshall; *S. nigra* Marshall var. *vallicola* Dudley; *S. vallicola* (Dudley) Britton & Shafer

Inner North Coast Ranges (Clear L., Lake Co., and Rumsey, Yolo Co.), Sierra Nevada Foothills, Great Central Valley, South Coast Ranges, Peninsular Ranges, East of Sierra Nevada (White Mts.), Mojave Desert, Sonoran Desert. Map 8. California to Utah and Texas southward to the northern half of Mexico.

Salix gooddingii differs from *S. nigra* by its yellow- to gray-brown branches and the frequent occurrence of pilose ovaries and capsules. The frequency of plants (studied in CAS) with pilose to glabrous ovaries is 54:14; in plants with mature capsules the frequency is about 1:1, indicating that pilosity is lost as fruits mature.

Fig. 7.
• *Salix geyeriana*

Fig. 8.
• *Salix gooddingii*

Fig. 9.
• *Salix hookeriana*

Fig. 10.
• *Salix jepsonii*

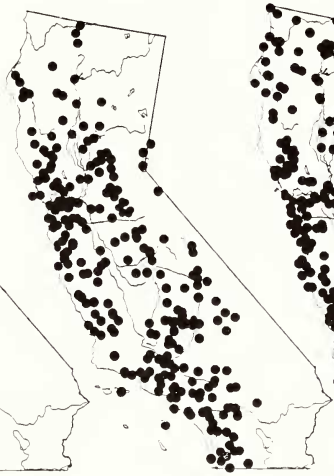

Fig. 11.
• *Salix laevigata*

Fig. 12.
• *Salix lasiolepis* var. *lasiolepis*

Maps 7–12.

The eastern American *S. nigra* typically has glabrous ovaries, but a specimen collected near Ottawa, Ontario, Canada (*Argus 13582*, CAN) had pilose ovaries indicating that both taxa have the genetic capability of producing pilose ovaries. A search for this character in hundreds of other specimens of *S. nigra* was unsuccessful. The two taxa are distinct, even where they overlap in central Texas, and should maintained as species.

Occasionally, specimens of *S. gooddingii* may flower a second time in the year by producing catkins in the axil of leaves (*Wilder 4829*, Prado Dam, Riverside Co., 30 Oct. 1970, POM); this character is diagnostic of *S. bonplandiana* Kunth. The possibility that, in *S. gooddingii*, it reflects hybridization with *S. bonplandiana* should be studied (see *S. laevigata*).

11. *Salix hookeriana* Barratt ex Hook. Fl. bor.-amer. 2:145. 1838

S. piperi Bebb

North Coast, Klamath Ranges, Outer North Coast Range. Map 9. Coastal Alaska southward to California.

Salix hookeriana is morphologically variable. Branchlets and leaves are densely villous to glabrous (with indumentum consisting of white hairs or a mixture of white and ferruginous hairs), ovaries are villous to glabrous, and catkins are sessile (flowering precociously [appearing before the leaves]) or on flowering branchlets up to 23 mm long (then flowering coetaneously [appearing with the leaves]). The species is typically densely hairy but glabrous extremes have been named *S. piperi*. This variant occurs with the typical species in northwestern California (mouth of Caspar R, Mendocino Co., and gravel bars of Smith R, Del Norte Co.) and adjacent Oregon. Populations containing intermediates occur at Paine's Cr., Tehama Co., and on gravel floodplains of the Van Duzen R., Humboldt Co. Glabrous plants suggest *S. hookeriana* × *S. lasiolepis* and among the type material of *S. piperi* is a specimen originally so named. Only the glabrous variant, however, seems to occur in two, high elevation populations (South Yager Cr. and Snow Camp, Humboldt Co., 300–1380 m). Field study of these populations may shed some light on its origin.

Populations in Alaska, which are not sympatric with *S. scouleriana* (a species with leaf indumentum containing ferruginous hairs), have leaf indumentum consisting of only white hairs. From British Columbia south to California indumentum often is a mixture of white and ferruginous hairs. This character may have been introduced into *S. hookeriana* by hybridization and introgression with *S. scouleriana*. These species usually occupy different habitats, the former coastal dunes, marshes, and river floodplains, the latter upland forests. Also, *S. hookeriana* usually lacks stipules and has villous

or tomentose branchlets and petioles; *S. scouleriana* is stipulate and has velutinous branchlets and petioles. Many plants recombine these characters in ways that suggest hybridization and introgression.

12. *Salix jepsonii* C. K. Schneider, J. Arnold Arbor. 1:89. 1919

S. sitchensis Sanson ex Bong. var. *angustifolia* Bebb.; *S. sitchensis* var. *ralphiana* (Jeps.) Jeps.

Klamath Ranges, High Cascade Ranges, High Sierra Nevada. Map 10. Endemic to California and Nevada.

It is difficult to consistently separate *S. jepsonii* from *S. sitchensis*. The only character that seems useful is leaf width; *S. jepsonii* generally has narrower leaves (length/width (2.5) 3.3–7.3) than *S. sitchensis* (length/width 1.7–3.9). Schneider (1919) separated them on stamen number (*S. sitchensis* with one stamen per flower and *S. jepsonii* with two) and, on these grounds, even placed them into different sections. A study of 22 staminate specimens of *S. jepsonii* revealed 17 with two stamens and seven with one. Stamen number was also found to sometimes vary even within a single catkin. *S. jepsonii* generally occurs at higher elevations than *S. sitchensis* and their ranges are largely allopatric. Specimens of *S. jepsonii* from high elevations in Siskyou and Trinity cos. are particularly difficult to separate from *S. sitchensis*. A specimen from Stirling, Butte Co. (*A. A. Heller 10832* MO), identified as *S. jepsonii*, strongly resembles *S. sitchensis* but is "out-of-range" for that species. Similarly the holotype of *S. sitchensis* f. *ralphiana* Jepson (*Jepson 690* JEPS), tentatively annotated as *S. jepsonii* by both Schneider (in 1919) and Argus (in 1989), resembles *S. sitchensis* but is also "out-of-range". Crovello (1968) maintained *S. jepsonii* as a distinct "taxospecies" but commented that further study was needed. The hypothesis that *S. jepsonii* originated through hybridization between *S. sitchensis* and *S. drummondiana* needs testing.

13. *Salix laevigata* Bebb, Amer. Naturalist 8:202. 1874

S. bonplandiana Kunth var. *laevigata* (Bebb) Dorn; *S. laevigata* var. *angustifolia* Bebb; *S. laevigata* var. *araquipa* (Jeps.) C. R. Ball; *S. laevigata* var. *congesta* Bebb

Throughout California except for the Modoc Plateau and Sonoran Desert. Gaps occur in the northeastern Klamath Ranges, much of the northern High Sierra Nevada, the eastern Mojave Desert, and the Desert Mts. Map 11. Oregon and Utah southward to California and Arizona.

Salix laevigata is closely related to *S. bonplandiana*. They are separated by leaf shape (length/width: *S. laevigata* 3.3–(4.9)–5.8 vs *S. bonplandiana* 4.4–(6.5)–11.7), stipule length (*S. laevigata* 1.2–(5.2)–12 mm vs. *S. bonplandiana* 0–(1.8)–3.6 mm), and in length

of flowering branchlets on which the pistillate catkins are borne (*S. laevigata* 3–(11.4)–20 mm vs. *S. bonplandiana* 2.5–(6.4)–11 mm). In addition, *S. laevigata* is spring-flowering and has catkins borne on distinct flowering branchlets on branches of the previous year. The catkins of *S. bonplandiana* appear throughout the year and are borne sessile, or on short flowering branchlets, in the axils of long-persistent leaves. The two overlap in northern Baja California where intergradation is suspected. The species in this region need study.

Putative hybrids with *S. gooddingii* have been seen from Kern Co., east of Mt. Mesa, *Dunn, Conrad & Kenney 20855* (NY); Shasta Co., between Middle Creek Sta. and Keswick, *Heller 7950* (CAS); and Tehama Co., Red Bluff, *Ball, Smith & Bracelin 650* (POM).

14. *Salix lasiolepis* Benth. Pl. Hartw. 335. 1857 var. *lasiolepis*

S. lasiolepis var. *bracelinae* C. R. Ball; *S. lasiolepis* var. *falax* Bebb; *S. lutea* var. *nivaria* Jeps.; *S. lasiolepis* var. *sandbergii* (Rydb.) C. R. Ball; *S. tracyi* C. R. Ball

Throughout California. Absent from much of the Mojave and Sonoran Deserts (the record plotted at Parker Dam is in Arizona). Map 12. Washington and Idaho southward to California and Texas and northern and central Mexico.

Several varieties of *S. lasiolepis* have been named (including var. *bigelovii*, var. *sandbergii*, and var. *bracelinae*); but, with the exception of var. *bigelovii* (see below), the separating characters appear to be developmental. Tagged plants from Los Angeles and Siskiyou cos. (UC/JEPS) show such wide variation in leaf shape and in leaf apex shape that early season collections were named var. *bigelovii* and later season collections var. *lasiolepis*. Hybridization also may also contribute to this variation. The highly variable populations in northern coastal regions (Gasquet, Del Norte Co., and Mad R. and Petrolia, Humboldt Co.) suggest hybridization with *S. hookeriana*. The hybrid *S. lasiolepis* × *S. sitchensis* was reported from the San Bruno Mts, San Mateo Co. (McClintock and Knight 1968). This hybrid was not confirmed by this study.

15. *Salix lasiolepis* Benth. var. *bigelovii* (Torr.) Bebb in S. Watson, Bot. Calif. 2:86. 1879

S. bigelovii Torr., Pacif. Rail. Rep. 4:139. 1857

North Coast, Klamath Ranges, Outer and Interior North Coast Ranges, Central Coast, Outer South Coast Ranges, South Coast, Channel Islands. Map 13. Endemic to California and Oregon.

The coastal taxon, *S. lasiolepis* var. *bigelovii*, is a possible ecotype; it differs from var. *lasiolepis* in leaves narrowly to broadly obovate, densely woolly-tomentose on abaxial surface, if becoming

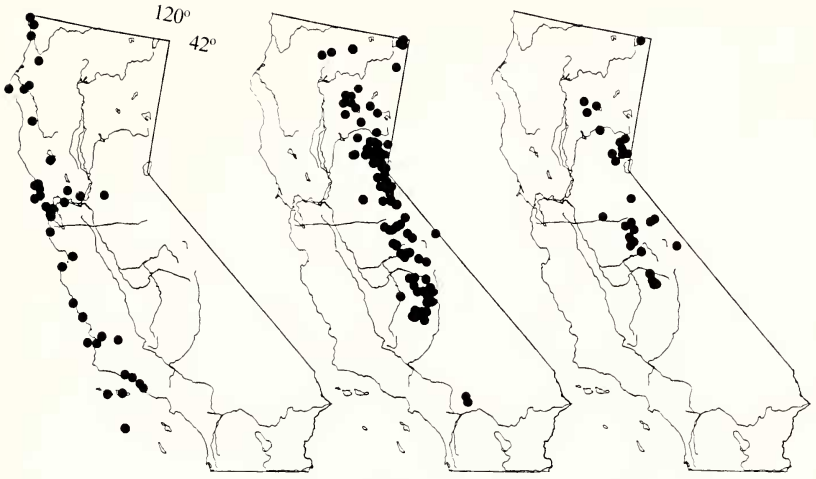

Fig. 13. • *Salix lasiolepis* var. *bigelovii*

Fig. 14. • *Salix lemmonii*

Fig. 15. • *Salix ligulifolia*

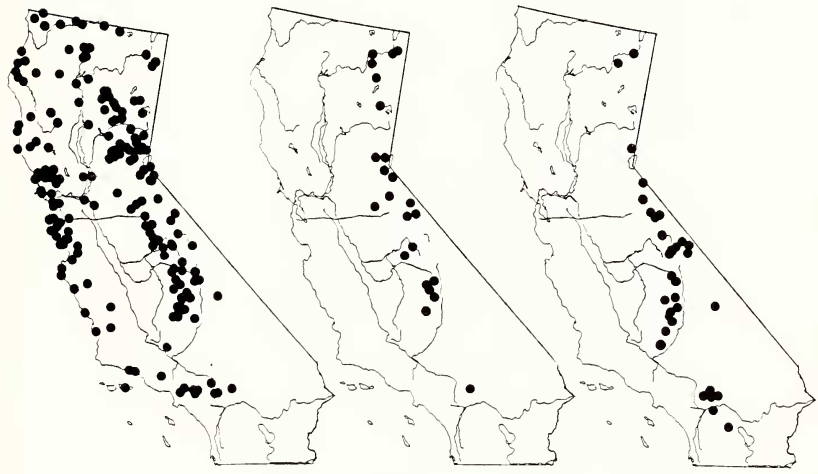

Fig. 16. • *Salix lucida* subsp. *lasiandra*

Fig. 17. • *Salix lucida* subsp. *caudata*

Fig. 18. • *Salix lutea*

Maps 13–18.

glabrous, then the blade coarsely veined, and leaf apex generally obtuse to rounded.

16. *Salix lemmonii* Bebb in S. Watson, Bot. Calif. 2:88. 1879

S. austinae Bebb; *S. lemmonii* var. *macrostachya* Bebb; *S. lemmonii* var. *melanopsis* Bebb; *S. lemmonii* var. *sphaerostachya* Bebb

Klamath Ranges (Mt. Eddy), High Cascade Range, High Sierra Nevada, San Bernardino Mts. (disjunct), Modoc Plateau (Goose L., Warner Mts.), East of Sierra Nevada (White Mts.). Map 14. British Columbia and Montana southward to California and Colorado.

A population of *S. lemmonii* on the shore of Webber Lake, Sierra Co. (*W. Dudley 5407–5411*, *5415*, and *5418* (DS)) seems to be intermediate to *S. geyeriana*. The catkins are short for *S. lemmonii* but the floral bracts are dark, the styles distinct, and the leaves are not as densely sericeous as in *S. geyeriana*.

Salix lemmonii exhibits both glaucous and non-glaucous branches and branchlets. Such plants, with a bluish-white bloom, are conspicuous and sometimes thought to be a different taxon. With the exception of Modoc Co., where only the glaucous-stemmed variant seems to occur, both types occur throughout the range of the species. This glaucescence variation is similar to that which occurs in *S. irrorata* Anderson (Argus 1995). It does not seem to be of taxonomic significance.

17. *Salix ligulifolia* (C. R. Ball) C. R. Ball in E. C. Smith, Amer. Midl. Nat. 27:236. 1942

S. eriocephala Michx. var. *ligulifolia* (C. R. Ball) Dorn

High Cascade Range, High Sierra Nevada, Modoc Plateau (Warner Mts.), East of Sierra Nevada (Mono L.). Map 15. Montana and South Dakota southward to California and New Mexico.

See *Salix prolixa*.

18. *Salix lucida* Muhl. subsp. *lasiandra* (Benth.) E. Murray, Kalmia 15:11. 1984 "1985"

S. lasiandra Benth. Pl. Hartweg. 335. 1857; *S. lasiandra* var. *abramsii* C. R. Ball; *S. lasiandra* var. *lancifolia* (Anderson) Bebb

Throughout California except San Joaquin Valley, Peninsular Ranges, most of Mojave Desert (known only at Darwin Springs), and Sonoran Desert. Map 16. Alaska and western Northwest Territories southward to California and New Mexico.

See *Salix lucida* subsp. *caudata*.

19. *Salix lucida* Muhl. subsp. *caudata* (Nutt.) E. Murray, Kalmia 15:11. 1984 "1985"

S. caudata (Nutt.) A. A. Heller; *S. lasiandra* var. *bryantiana* C.

R. Ball & Bracelin; *S. lasiandra* var. *caudata* (Nutt.) Sudw.; *S. lasiandra* var. *fendleriana* (Anderson) Bebb; *S. pentandra* L. [var.] *caudata* Nutt., North Am. Sylva 1:61. 1842

High Sierra Nevada, San Bernardino Mts. (disjunct), Modoc Plateau (Goose L. and Pit River, Modoc Co.), East of Sierra Nevada (Bridgeport and Tioga L., Mono Co.). Map 17. Alaska and western Northwest Territories southward to California, Colorado, and South Dakota.

Salix lucida subsp. *caudata* is separated from subsp. *lasiandra* by having leaves nonglaucous abaxially and with stomata on both adaxial and abaxial surfaces (amphistomatous) (Argus 1986a). Numerous specimens of subsp. *lasiandra* (plants with leaves glaucous abaxially) are also amphistomatous. Such intermediates (CAS and DS) occur in Fresno Co., Kings Canyon; Inyo Co., Whitney Portal; Modoc Co., Alturas; Mono Co., Convict L. and Bridgeport; Nevada Co., lower end of Donner L., Boca, and Truckee; Plumas Co., Portola and Butterfly Cr.; Shasta Co., La Maine; Tulare Co., various localities; and Tuolumne Co., Twain Harte. Sympatric populations in Big Bear Valley and Big Bear Lake, San Bernardino Co., could be studied to determine if these taxa deserve even subspecies rank.

20. *Salix lutea* Nutt. N. Amer. Sylva 1:63. 1842

S. cordata Muhl. var. *watsonii* Bebb; *S. lutea* var. *watsonii* (Bebb) Jeps.; *S. eriocephala* Michx. var. *watsonii* (Bebb) Dorn; *S. rigida* Muhl. var. *watsonii* (Bebb) Cronquist

Central and southern High Sierra Nevada, Southwestern California (disjunct in San Bernardino and San Jacinto mts.), Modoc Plateau (Alturas and Adin), East of Sierra Nevada, Mojave Desert (disjunct in Paramint Mts.). Map 18. Northwest Territories eastward to Quebec and southward to California, Arizona and Iowa.

Salix lutea differs from the related *S. eriocephala* in having one-year-old branches yellowish and smooth, lacking an exfoliating epidermis, and branchlets glabrous or, if hairy, not with long, soft, wavy hairs. It has been treated as a variety of *S. eriocephala* by Dorn (1995), but its phenetic distance from other members of *S.* sect. *Cordatae* supports species rank (Argus 1997).

21. *Salix melanopsis* Nutt. N. Amer. Sylva 1:78. 1842

S. exigua Nutt. var. *gracilipes* (C. R. Ball) Cronquist; *S. melanopsis* var. *bolanderiana* (Rowlee) C. K. Schneider; *S. exigua* subsp. *melanopsis* (Nutt.) Cronquist

North Coast (Gasquet and Smith R., Del Norte Co.), Klamath Ranges (Seiad Valley, Siskiyou Co.), Cascade Range Foothills (Chico, Butte Co.), High Cascade Range (Chester, Plumas Co.), northern

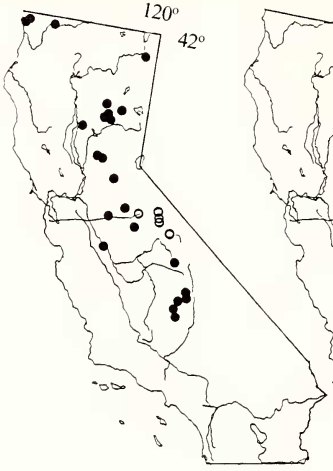

Fig. 19.
• *Salix melanopsis*
○ *Salix nivalis*

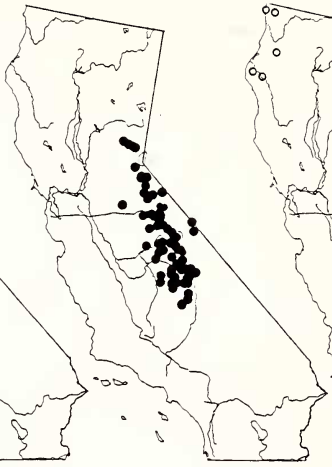

Fig. 20.
• *Salix orestera*

Fig. 21.
• *Salix petrophila*
○ *Salix sessilifolia*

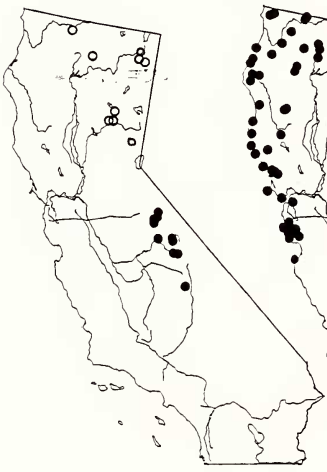

Fig. 22.
• *Salix planifolia*
○ *Salix prolixa*

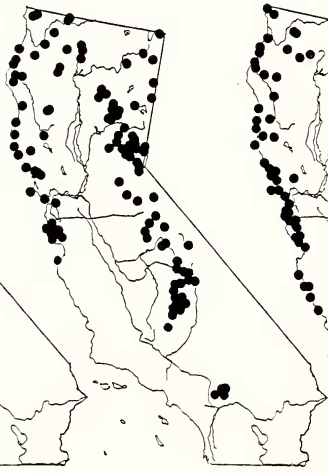

Fig. 23.
• *Salix scouleriana*

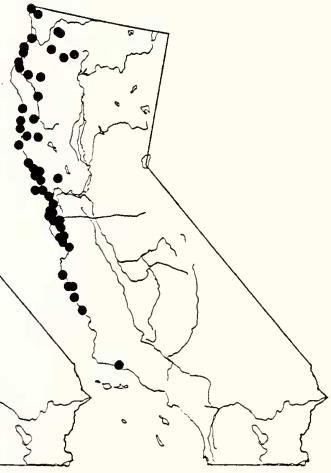

Fig. 24.
• *Salix sitchensis*

Maps 19–24.

Sierra Nevada Foothills (Spenceville and confluence of Bear R. and Wolf Cr., Nevada Co.), southern Sierra Nevada Foothills (Kernville, Kern Co.), High Sierra Nevada, Sacramento Valley (Knights Ferry, Stanislaus Co.), Modoc Plateau (Parker Cr., Modoc Co.). Map 19. British Columbia and Alberta southward to California and Wyoming.

22. *Salix nivalis* Hook. Fl. bor-amer. 2:152. 1838

S. nivalis var. *saximontana* (Rydb.) C. K. Schneider; *S. reticulata* L. subsp. *nivalis* (Hook.) A. Löve, D. Löve & B. M. Kapoor

Central High Sierra Nevada. Map 19. British Columbia and Alberta southward in the Cordillera to California and Colorado.

Salix nivalis is treated here as a species because hybridization in the region of overlap was localized and indistinct (Argus 1986b) and the phenetic distance between *S. nivalis* and *S. reticulata* (Argus 1997) supports specific rank.

23. *Salix orestera* C. K. Schneider, J. Arnold. Arbor. 1:164. 1920

S. commutata Bebb var. *rubicunda* Jeps.; *S. glauca* L. var. *orestera* (C. K. Schneider) Jeps.

Southern Sierra Nevada Foothills, High Sierra Nevada, East of Sierra Nevada (White Mts.). Map 20. Oregon, California, and Nevada.

Salix orestera is sometimes difficult to separate from *S. lemmonii* and *S. eastwoodiae*. The possibility that it originated through hybridization between the latter two species could be studied in the Kaiser Pass area, Fresno Co. (CAS), where all three species occur.

24. *Salix petrophila* Rydb. Bull. N. Y. Bot. Gard. 1:268. 1899

S. arctica Pall. var. *antiplasta* sensu auct.; *S. arctica* Pall. var. *petraea* (Andersson) Bebb; *S. arctica* Pall. subsp. *petraea* (Andersson) A. Löve, D. Löve & B. M. Kapoor

High Cascade Range (Mt. Lassen), High Sierra Nevada. Map. 21. Oregon and Montana southward in the Cordillera to California and New Mexico.

In modern floras *Salix petrophila* is treated as a synonym of *S. arctica* (e.g., Argus 1993, Goodrich 1983; Dorn 1977), sometimes as *S. arctica* var. *petraea* (Hitchcock et al. 1964). A study of specimens in NA and NY and a phenetic study (Argus 1997) suggest that it is a distinct species. It differs from *S. arctica* in leaves lacking long, straight hairs on the abaxial surface, especially the proximal leaves; floral bracts brown to tawny, not dark brown to black, bracts usually glabrous or clothed with wavy hairs, not the long straight hairs characteristic of *S. arctica*; and branchlets glabrous.

In California, *S. petrophila* resembles *S. cascadensis* Cockerell in its narrow, sharply pointed leaves and pale-colored floral bracts. Specimens originally identified as *S. cascadensis* (*Alexander & Kellogg 3376* and *Hoover 4483* NA) proved to be *S. petrophila*. The phenetic distance between *S. petrophila* and *S. cascadensis* is very close (Argus 1997); these taxa cluster with *S. arctica* and *S. spenophylla* Skvortsov and are placed with them in *S.* sect. *Diplodictya* C. K. Schneider (syn. *S.* sect. *Arcticae* Rydb). These species deserve further study.

25. *Salix planifolia* Pursh, Fl. Am. Sept. 2:611. 1814 subsp. *planifolia*

S. monica Bebb; *Salix phylicifolia* L. var. *monica* (Bebb) Jeps.; *S. phylicifolia* var. *planifolia* (Pursh) Cronquist; *S. planifolia* var. *monica* (Bebb) C. K. Schneider

High Sierra Nevada. Map 22. Alaska to Newfoundland, southward in the east in the mountains of New England and in the west to California, New Mexico, and South Dakota.

In California, *S. planifolia* is represented by a subalpine variant, (sometimes called var. *monica*). These plants are prostrate to erect shrubs (up to 1 m), with diminutive (20–43 mm long), elliptic, usually amphistomatous leaves, and small catkins (10–45 mm long). It was not recognized as a distinct taxon in *The Jepson Manual* (Argus 1993) but it deserves further study.

26. *Salix prolixa* Andersson, Monogr. Salicum 94. 1867

S. cordata sensu auct.; *S. cordata* Muhl. var. *mackenzieana* Hook.; *S. eriocephala* Michx. var. *mackenzieana* (Hook.) Dorn; *S. mackenzieana* (Hook.) Andersson; *S. rigida* Muhl. var. *mackenzieana* (Hook.) Cronquist

Klamath Range (Yreka, Siskiyou Co.), High Cascade Range (Glazier, Siskiyou Co.), northern High Sierra Nevada (Greenville, Quincy, and Meadow Valley Cr., Plumas Co; Camassia Bend, CA Hwy 89, Sierra Co.), Modoc Plateau (Alturas and Contrall's Mill, Modoc Co.). Map 22. The Yukon and Northwest territories southward to California and Wyoming.

In their overall morphology, *S. prolixa* and *S. ligulifolia* are very similar. They may be separated by *S. prolixa* having narrowly elliptic to obovate leaves (L/W 2.4–4.5), base often cordate, stipules with an obtuse to rounded apex, and usually longer stipes (1.3–4.2 mm long); *S. ligulifolia* has ligulate to very narrowly elliptic leaves (L/W 2.9–6.4), base rarely cordate, stipules with acute to acuminate apex, and usually shorter stipes (0.9–2.5 mm long).

This species has been treated as a variety of *S. eriocephala* by

Dorn (1995), but its phenetic distance from other members of *S.* sect. *Cordatae* supports species rank (Argus 1996).

S. reticulata L. subsp. *nivalis* = *S. nivalis*.

27. *Salix scouleriana* Barratt ex Hook. Fl. Bor.-amer. 2:145. 1838

S. scouleriana var. *coetanea* C. R. Ball; *S. scouleriana* var. *flavescens* (Nutt.) J. K. Henry; *S. scouleriana* f. *poikila* (C. K. Schneider) C. K. Schneider

North Coast, Klamath Ranges, Outer and High North Coast Ranges, High Cascade Range, southern Sierra Nevada Foothills (Upper Lucas Cr., Tehachapi-Kernville region, Kern Co.), High Sierra Nevada, Central Coast, San Francisco Bay Area, San Bernardino Mts. (disjunct), Modoc Plateau (including Warner Mts.). Map 23. Alaska and the western Northwest Territories eastward to Saskatchewan and southward to California, New Mexico, South Dakota, and northern Mexico.

Salix scouleriana occurs on the Smith R., Del Norte Co., along with *S. hookeriana* and *S. lasiolepis*. Its flowers are unusual in having hairy ovaries, long, broad-lobed stigmas, and longer anthers, but vegetatively it compares with specimens of *S. scouleriana* that lack velutinous petioles and branchlets. All three species may have leaves with ferruginous hairs. In *S. scouleriana* these hairs differ in having a prominently reddish base which makes the leaf surface appear punctate.

28. *Salix sessilifolia* Nutt. N. Amer. Sylva 1:68. 1842

S. parksiana C. R. Ball

North Coast, Klamath Ranges, Outer North Coast Range. Map 21. Coastal British Columbia to California.

Salix parksiana may be the hybrid *S. melanopsis* × *S. sessilifolia*.

29. *Salix sitchensis* Sanson ex Bong. Mem. Acad. St. Petersb. 6. 2: 162. 1832 [1833?]

S. coulteri Andersson; *S. sitchensis* var. *coulteri* (Andersson) Jeps.; *S. sitchensis* var. *parviflora* (Jeps.) Jeps.

North Coast, Klamath Ranges, Outer and Inner North Coast Ranges, Central Coast, San Francisco Bay Area, and South Coast (Santa Barbara). Map 24. Alaska southward to California and Montana.

Plants with leaves densely lanate to sericeous-lanate abaxially have been named *S. coulteri*. This variant does not seem to occur outside of northern California, but in California it is sympatric with typical *S. sitchensis*, which usually has leaves densely sericeous abaxially. Crovello (1968) correctly treated them as conspecific.

Similar extreme variation in leaf indumentum also occur in *S. scouleriana*. The genetics of these variants has not been studied.

Taxonomy of Introduced and Naturalized Willows

Few specimens of introduced *Salix* were seen from California. Only the tree willows, *S. alba, S. babylonica*, their cultivars and hybrids, and the shrubby *S. purpurea*. L. seem to be represented in herbaria. Their naturalized status is uncertain.

1. *Salix alba* L. var. *vitellina* (L.) Stokes, Bot. Mat. Med. 4:506. 1812

S. alba var. *tristis* (Ser.) Gaudin; *S. vitellina* L., Sp. Pl. 1016. 1753; *S. alba* subsp. *vitellina* (L.) Shübler & Martens

Salix ×*ehrhartiana* G. Meyer, Chloris han. 486. 1836

S. alba × *S. pentandra*

Salix ×*rubens* Schrank, Baier. fl. 1:226. 1789

S. alba × *S. fragilis*

Salix ×*sepulcralis* Simonk. Oesterr. Bot. Zeitschr. 40:424. 1890

S. alba var. *vitellina* × *S. babylonica*

Specimens representing typical *S. alba* were not seen; all specimens were referred to var. *vitellina* or the above hybrids.

2. *Salix babylonica* L. Sp. Pl. 2:1017. 1753

Salix ×*pendulina* Wenderoth, Schrift. Nat. Ges. Marb. 2:235. 1831 [pro sp.]

S. babylonica × *S. fragilis*

Salix ×*pendulina* cv blanda

S. ×*blanda* Andersson, Monogr. Salicum 50. 1867

Specimens resembling *S. babylonica* or possibly *S.* ×*pendulina* cv. blanda, were seen from Santa Barbara and Santa Clara cos. Other specimens were the hybrid *S.* ×*sepulcralis* (see *S. alba*). *Salix* ×*pendulina* is represented by three cultivars one of which is cv. blanda.

Key to the Commonly Cultivated Tree Willows (see also Meikle 1984).

1. Twigs erect or spreading 2
   2. Twigs brown or olive 3
      3. Leaf blade dull or silky adaxially, hair white 4
         4. Leaf blade persistently silky adaxially . . . . . *S. alba* var. *alba*
         4′. Leaf blade becoming glabrous adaxially . . . . . *S.* ×*rubens*

3′. Leaf blade glossy adaxially, hair white and rusty . . . *S.* ×*ehrhartiana*
2′. Twigs yellow or golden . . . . . *S. alba* var. *vitellina*
1′. Twigs pendent 5
5. Twigs yellow or golden; leaf blade silky or glabrate . . . . . *S. alba* var. *vitellina* cv. pendula
5′. Twigs brown or olive; leaf blade glabrate 6
6. Catkin on distinct, leafy shoots, generally greater than 2 cm . . . . . *S.* ×*sepulcralis*
6′. Catkin subsessile
7. Catkins generally less than 2 cm, ovary abruptly tapering to style . . . . . *S. babylonica*
7′. Catkins generally more than 2 cm, ovary gradually tapering to style . . . . . *S.* ×*pendulina*

Phytogeography

Salix occur throughout California. The geographic region with the greatest *Salix* diversity (Table 1) is the Sierra Nevada Region (21 taxa), followed by Northwestern California (18 taxa), Cascade Ranges (14 taxa), Modoc Plateau (13 taxa), East of Sierra Nevada (12 taxa), Southwestern California (11 taxa), Central Western California (9 taxa), Great Central Valley (7 taxa), Mojave Desert (5 taxa), and the Sonoran Desert (3 taxa). The subregion with the greatest *Salix* diversity is the High Sierra Nevada Subregion (20 taxa) followed closely by the Klamath Ranges (16 taxa) and the High Cascade Ranges (14 taxa). *Salix exigua* and *S. lasiolepis* occur in all subregions; *S. laevigata* is missing only from the Sonoran Desert Subregion; and *S. lucida* subsp. *lasiandra* is missing only in the Sonoran Desert Subregion and the Peninsular Ranges Subregion (San Jacinto Mts.). The species with the smallest range in California is *S. brachycarpa*, known only from the Central High Sierra Nevada (Major & Bamberg 1963). Wide disjunctions occur within the mountains of Southern California: *S. geyeriana, S. lemmonii, S. lucida* subsp. *caudata, S. lutea*, and *S. scouleriana* all occur as disjuncts in the San Bernardino Mts., and *S. eastwoodiae* is disjunct in the San Jacinto Mts.

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TABLE 1. GEOGRAPHICAL OCCURRENCE OF *SALIX* IN CALIFORNIA. NW = Northwestern California Region, CaR = Cascade Ranges Region, SN = Sierra Nevada Region, GV = Great Central Valley Region, CW = Central Western California Region, SW = Southwestern California Region, MP = Modoc Plateau Region, SNE = East of Sierra Nevada Region, DMoj = Mojave Desert Region, DSon = Sonoran Desert Region (following Hickman 1993).

Taxa	NW	CaR	SN	GV	CW	SW	MP	SNE	DMoj	DSon
S. bebbiana							X			
S. boothii	X	X	X				X	X		
S. breweri	X				X					
S. brachycarpa			X							
S. delnortensis	X									
S. drummondiana			X							
S. eastwoodiae	X	X		X			X	X		
S. exigua	X	X	X	X	X	X	X	X	X	X
S. geyeriana		X	X			X	X	X		
S. gooddingii	X		X		X	X		X	X	X
S. hookeriana	X									
S. jepsonii	X	X	X							
S. laevigata	X	X	X	X	X	X		X	X	
S. lasiolepis bigelovii	X				X					
S. lasiolepis lasiolepis	X	X	X	X	X	X	X	X	X	X
S. lemmonii	X	X	X			X	X	X		
S. ligulifolia		X	X				X	X		
S. lucida caudata			X			X	X	X		
S. lucida lasiandra	X	X	X	X	X	X	X	X	X	
S. lutea			X			X				
S. melanopsis	X	X	X	X			X			
S. nivalis			X							
S. orestera			X					X		
S. petrophila		X	X							
S. planifolia			X							
S. prolixa	X	X	X				X			
S. scouleriana	X	X	X		X	X	X			
S. sessilifolia	X									
S. sitchensis	X				X	X				

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